

Monte Carlo Calculations of an experimentally critical UO₂-PHW Power Reactor using ENDF/B-VI Release 8 and ENDF/B-VII Beta 2

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The calculation with MCNP5 Monte Carlo code of some of the critical configurations of the Atucha-I reactor measured during the experiments performed during first criticality is presented.

The main objective of this calculation was to know the differences on results using ENDF/B-VI.Revision 8 and ENDF/B-VII Beta2 nuclear data, tacking into account that new calculations are performed for the second unit under construction (Atucha-II) with similar design as Atucha-I but bigger in power and number of channels than Atucha-I and it is useful to know the performance of new nuclear data for this type of reactors.

Atucha-I is a 340 MWe nuclear station D₂O moderated and cooled, of German (Siemens) pressure vessel design located in Argentina. It has 253 vertical coolant channels and the fuel assemblies (FA) are clusters of 36 natural UO₂ rods with a structural rod (a Zry hollow tube in the outer ring). Power regulation is performed through 29 slightly oblique absorber rods of hafnium and steel.

From the measurements (in 1974) of critical configurations at first criticality of Atucha-I , two cases were selected for calculating with MCNP5 code with all control rods out and isothermal conditions, one at 60 C with critical boron concentration of 12.7 ppm, and another at 210 C with critical boron concentration of 11 ppm.

Four sets of cross sections in ACES format were generated with NJOY-99.125 for all isotopes included on the benchmark, two from ENDF/B-VI.Revision 8 and two from ENDF/B-VII Beta2, both at 60 and 210 C.

By first time, full 3d core MCNP model was used. For this benchmark, each fuel channel was modeled without geometrical approximations. The model includes the 29 guide tubes of control rods (Zry). 50k histories and 1k cycles were used in each MCNP5 calculation. Standard deviations for k-effective are between 6 and 7.10⁻⁵.

The experimental error on k-effective is ± 1.67 mk (1mk=100 pcm). This value is the result of estimated effects of measurement errors of D₂O purity, core temperature and B concentration. Values obtained of k-effective with MCNP are very close to experimental critical condition for ENDF/B-VI and between -1.9 and -0.3 mk, For the case with ENDF/B-VII Beta 2, the k-effective values obtained are between +4.7 and +5.6 mk. Additional calculations were made with ENDF/B-VI replacing one by one nuclear data of U238, U235, Zr and D₂O from ENDF/B-VII Beta2.

The main conclusion is that the calculation of the two critical configurations showed a very slight underprediction of k-effective for ENDF/B-VI, but the results obtained with ENDF/B-VII beta2 show an overestimation of 5-6 mk mainly due to U238 new data. More details of results and extension to other configurations will be included on the full report.